DHS ASC PI meeting February 16, 2005

Building a National Decision Support System for Evaluation and Control of Foot-and-Mouth Disease Outbreaks

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FMD represents a major threat to the national economy

The World Organization of Animal Health defines it as …

"**One of the most contagious diseases of mammals…**

which has as a great potential for causing **severe economic loss…"**

Computational models can help evaluate the scope of an epidemic and advise decision makers how to plan response

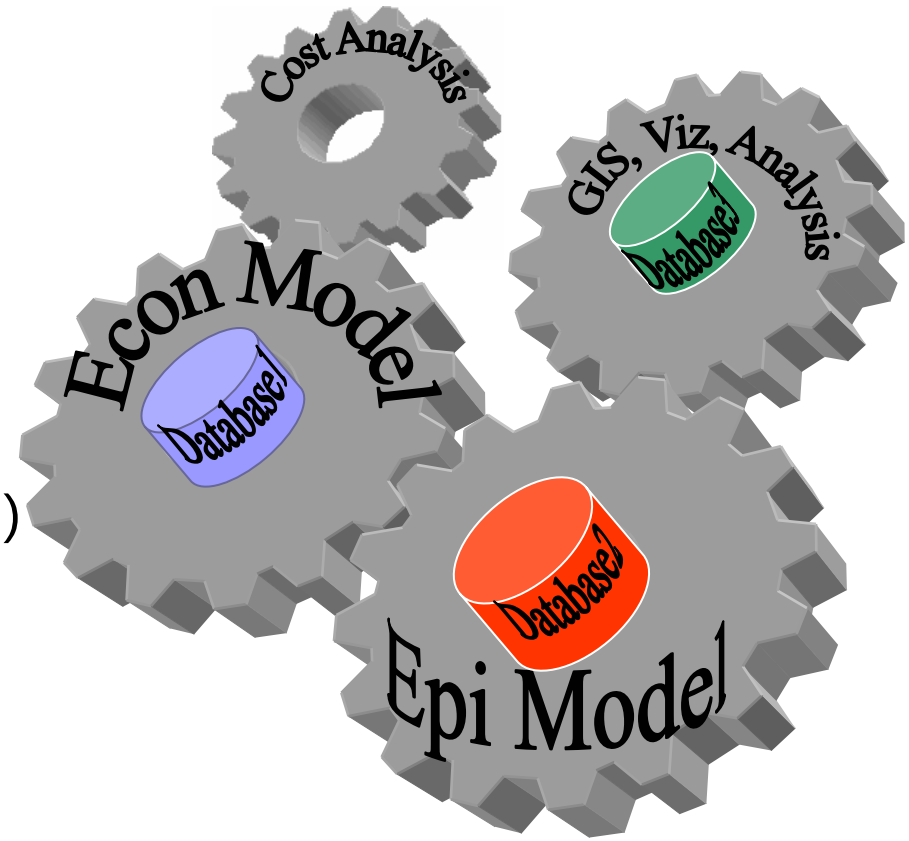
A decision support system (DSS) consists of …

Epidemic model (s)

Economic model (s)

Databases
(economic, epidemic, geographic,…)

Tools
(statistical and sensitivity analysis, visualization, optimization, GIS coupling,…)



As part of the ASC program we performed a review and gap analysis of existing FMD epidemic models and approaches

Early models

Later models

On-the-farm (intra-herd) models

Simple ODE models

deal with mean numbers of susceptible and infected animals

Stochastic simulation models

each animal is a simple agent

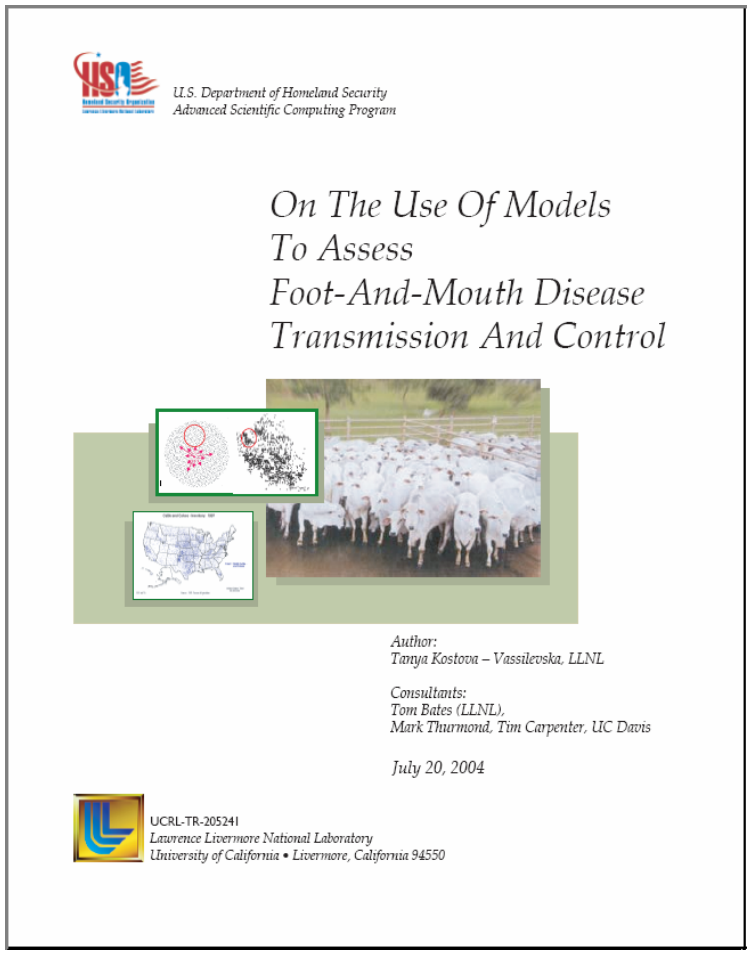
Herd-based models

Each herd is an agent

Non-spatial and Spatial

Spatially-uniform Spatially - explicit

Top-down and Bottom-up models


U.S. Department of Homeland Security
Advanced Scientific Computing Program

On The Use Of Models
To Assess
Foot-And-Mouth Disease
Transmission And Control

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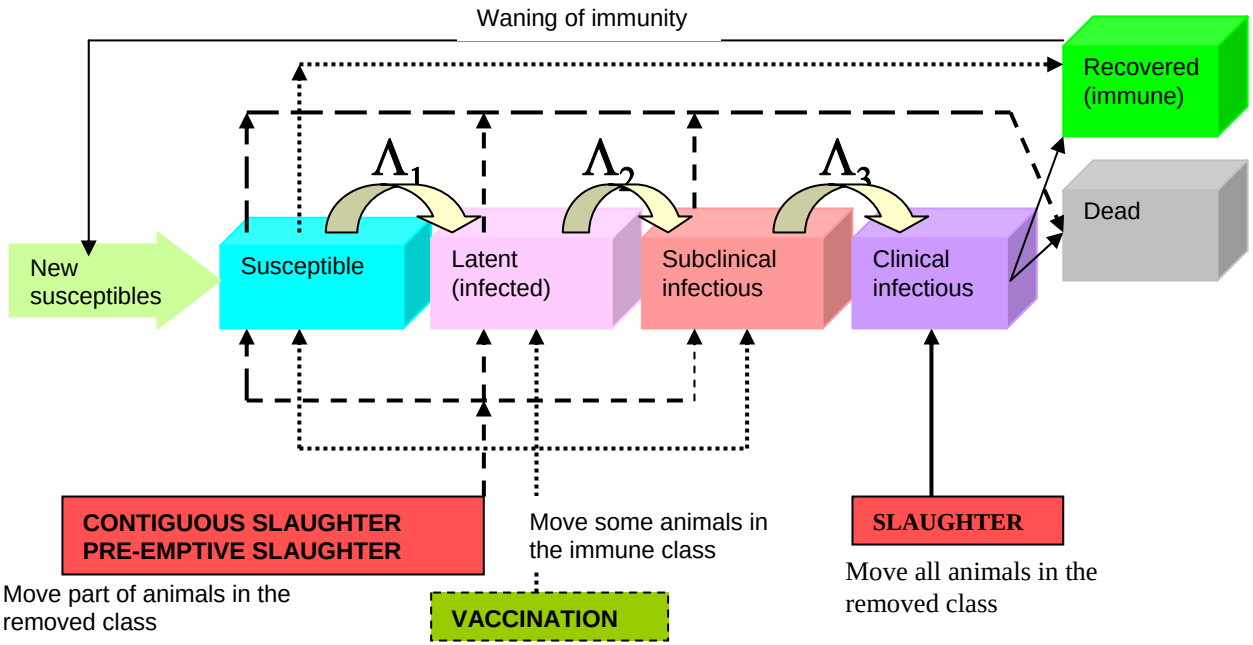
Epidemic models have a common logic



Schematic representation of the action of control strategies superimposed on a baseline epidemic model.

Several foreign and two US models have been published

Three models were used during the 2001 UK epidemic to advise policy makers
Recommendations of contiguous slaughter were followed and resulted in the killing of 600 000 cattle, 3M sheep and other livestock, most of these probably uninfected.

Among these was EpiMAN, a New Zealand owned DSS.

Two US models have been published:the “UC Davis” and the “USDA” models.

Both models continue development under different small funding contracts.

The review revealed the limitations of each model and the necessity of additional research, development and data

We summarized the features of the models in a table.

Foreign models are not immediately adaptable to the US realities

The most comprehensive model EpiMan is a commercial software, “hard-wired” for NZ (mainly sheep industry); comparatively small - scale.

US agricultural management practices are different;
The scale of the US livestock production is different;
The economic realities are different;
Issues of privacy, sensitive information.

We recommended the development of a national decision support system based on the “UC Davis” model (2004 meeting with DHS managers)

The review triggered considerable interest and led to an invitation for a proposal for the development of a DSS

"Spin-off project" support

White paper written with Tom Bates (BKC)

DHS promised 2 year funding for a DSS version 1 ("check is in the mail")

Continued model evaluation efforts
(comparison of continued USDA effort and continued development of the "UC Davis model", of a BKC "bioterrorist scenario evaluations" DHS funded effort)

USDA wants to play together (on separate funding)
Centers for excellence (TAMU, UC Davis) want to play together

The review uncovered research topics than need to be addressed to support the development of the DSS

Develop expertise in large-scale spatially explicit stochastic simulations
How many are enough? How to make sims faster?

Methods to develop "adaptively-predictive" models; i.e., models that improve their predictive accuracy upon use of newly arriving data.

Limitations of simulations with uniform versus aggregated farm spatial data.

Efficient discrete optimization techniques.
(for the purpose of fast determination of optimal strategic responses)

Fast, efficient methods for sensitivity analysis of agent-based models.

Exploration of methods to combine agent-based models and network models.

Smaller, Short-Term Tasks

Intra-herd modeling that considers the specifics of the farm management practices.
Size of initial infected area
Risk maps

Current and near future research

Paper summarizing the review results, in preparation

Started work on the requirements on an intra-herd FMD model

Paper on the calculation of R0 for a certain type of epi models (used to FMD by LANL)

How is R0 calculated in the case of stochastic simulations?

Methods for sensitivity analysis for discrete stochastic sims?

Agents as a part of a complex network?

As a conclusion…

we hope we will never have a real need for our DSS

nor for the results from it …